Chemical and Biological Agent Sensor/Detector Systems Technology Development for Applications in the Global War on Terrorism

Presented by Marc Rippen

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The Chemical/Biological Threat of the Past (C

- Long range delivery vehicles
- Large areas of contamination
- Technology and capability restricted to major powers
- Refined and specific chemical and biological agents

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Examples of Conventional CBAs

- Pure chemical agents
  - *Nerve*: Tabun (GA), Sarin (GB),Soman (GD),V Agents (VX)
  - *Blister*: Sulfur Mustard (H), Distilled Mustard (HD), Nitrogen Mustard (HN 1,3), Mustargen (HN 2), Lewisite (L), Phosgene Oxime (CX)
  - *Blood Asphyxiants*: Hydrogen Cyanide (AC), Cyanogen Chloride (CK) Arsine (SA)
  - *Toxic Industrial Chemicals*: HCl, H2SO4, HF, Phosgene Gas, and hundreds of others
- Binary and tertiary chemical agent systems
- Bacterial pathogens
  - Anthrax, Brucellosis, Plague, Tularemia, Q Feve
- Viral pathogens
  - Smallpox, Viral Hemorrhagic Fevers
- Biological toxins
  - Ricin, Venoms, Botulinum, Staphylococcal enterotoxin B, Trichothecene mycotoxins (T2)

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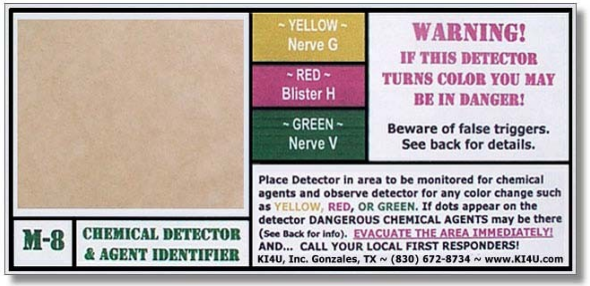
Technology of the Past

M256A1 Chemical Agent Detector Kit

Chemical Agent Monitor (CAM)

Bruker Daltonics CBMS Block III


~ YELLOW ~
Nerve G
~ RED ~
Blister H
~ GREEN ~
Nerve V
WARNING!
IF THIS DETECTOR TURNS COLOR YOU MAY BE IN DANGER!
Beware of false triggers. See back for details.
Place Detector in area to be monitored for chemical agents and observe detector for any color change such as YELLOW, RED, OR GREEN. If dots appear on the detector DANGEROUS CHEMICAL AGENTS may be there (See Back for info). EVACUATE THE AREA IMMEDIATELY! AND... CALL YOUR LOCAL FIRST RESPONDERS!
KI4U, Inc. Gonzales, TX ~ (830) 672-8734 ~ www.KI4U.com
M-8
CHEMICAL DETECTOR & AGENT IDENTIFIER

M9 CHEMICAL DETECTOR
WARNING IF THIS PAPER TURNS COLOR YOU MAY BE IN DANGER!
Place Detector in the area you want to monitor for chemical agent aerosols and observe for any change in color.
If Detector turns color such as PINK, RED, REDDISH BROWN, or RED PURPLE, there may be DANGEROUS CHEMICAL GASES in the area. (beware of false triggers, read back for more details)
If chemical agents are detected, EVACUATE THE AREA IMMEDIATELY! CALL FIRST RESPONDERS!
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Biological Culture Analysis

CWA Detector and Alarm M43A1 (ACADA)

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The Chemical/Biological Threat of Today

- Terrorist objectives
- Terrorist delivery technique
- Use of conventional agents (proliferation) and/or improvised agents of opportunity (release of toxic industrial chemicals)
- High profile targets
- Garage laboratory agent manufacture
- Biotechnology transfer

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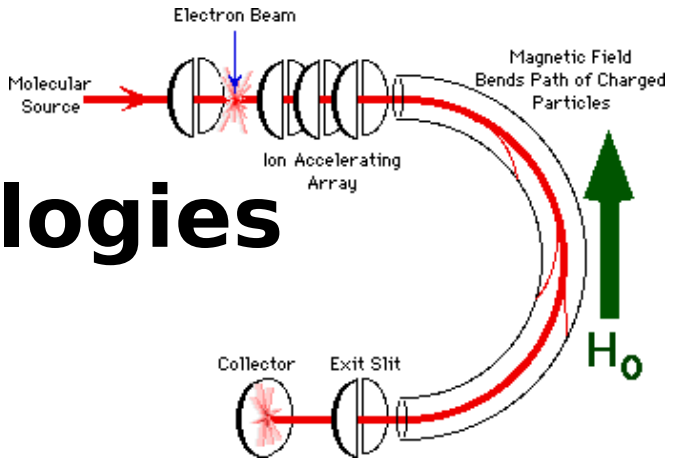

Detection Technologies

- Mass spectroscopy
  - Uses ion mass spectral fingerprint or specific molecular ion masses unique to agent
  - Most sensitive, linear responding and most discriminative technique
- UV/FTIR/VIS spectroscopy
  - Uses absorption/fluorescence/emission spectral wavelength fingerprint unique to agent
  - Can be used in stand off modes, can be very sensitive, not highly discriminative with complex samples
- Physical property
  - Uses unique physical characteristic to identify agent such as conductivity, density, polarity
- Chemical property
  - Uses unique chemical reactivity of agent material
  - Bio-reactivity… uses detectable biochemical materials tailored to bind to specific proteins for tagging, requires pre amplification of targeted DNA protein after DNA extraction

Mass Spectroscopic Systems For BW and CW Applications

Minotaur 500 Specifications

Resolution:	Unit
Detection:	Positive and negative ion detection.
Analyzer:	Ion Trap Technology
MS3:	Demonstrated
Size:	60 cm x 40 cm x 30 cm
Weight:	22.73 kg – including protective case and pumps
Sensitivity:	Gas Phase Sample Continuous monitoring LOD ~ 17 ppb toluene
Mass Range:	350 amu, configurable depending on application
Power:	125 W (battery and 120V available)

Griffin Analytical

Chemical Biological Mass Spectrometer (CBMS) JPEO-CBD

Bruker Daltonics MM-2 Portable

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Ion Mobility Equipment

LCD - Lightweight CWA Detector Smiths Detection

RAID Mobile CWA Detector Bruker Daltonics

DynaSensor CWA detector General Dynamics

GE's EntryScan and Itemiser

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UV/FTIR/Visible Spectroscopy Equipment

HAZ-MAT ID CWA Detector SensIR Technologies

Joint Biological Point Detection System (JBPDS) General Dynamic

Joint Service Lightweight Standoff Chemical Agent Detector (JSLSCAD) General Dynamic

M21 Remote Sensing CWA Detector / Alarm (RSCAAL)

AP2C Remote Sensing CWA Detector / Alarm Proengin Inc.

UV Sentry Toxic Chemical Perimeter Monitor Ocean Optics, Inc.

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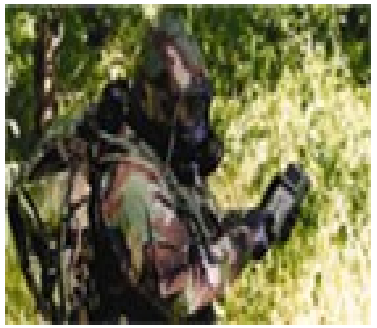
Physical Property Discrimination

HAZMATCAD and plus version SAW* plus with Electochemical Array CWA Detector Microsensor Systems Inc.



BAE JCAD Chem Sentry Chemical Detector System

(SAW*)

** Surface Acoustic Wave (SAW)*

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Biological Detectors

Hand-held PCR-based BWA Detector Smiths Detection

PCR-based BWA Detector Bruker Daltonics

Bio-Detector BWA Detector Smiths Detection

The GeneXpert System BWA Detector Cepheid

Idaho Technologies Ruggedized Advanced Pathogen Identification Device (RAPID)

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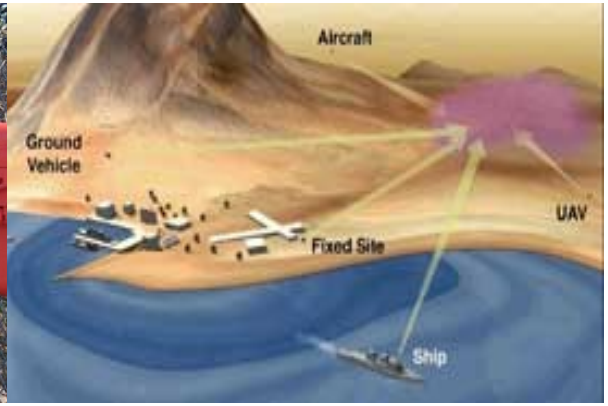
Deployment

- Point detection: direct sampling from immediate area of interest
- Perimeter detection: “fence post” detectors to alert movement of agent through perimeter
- Stand off detection: finding and analyzing “Clouds” from a distance



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New Technology Drivers

- Universal detection biological and chemical
- Sensitivity
- Cost
- Resolution
- Robustness
- Accuracy
- Connectivity
- Ease of use
- Portability
- Automation

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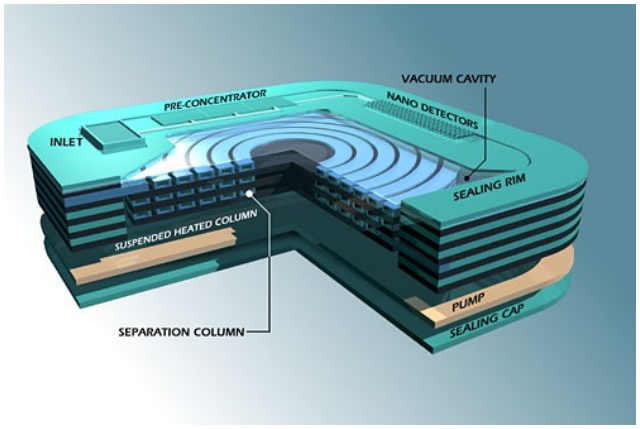
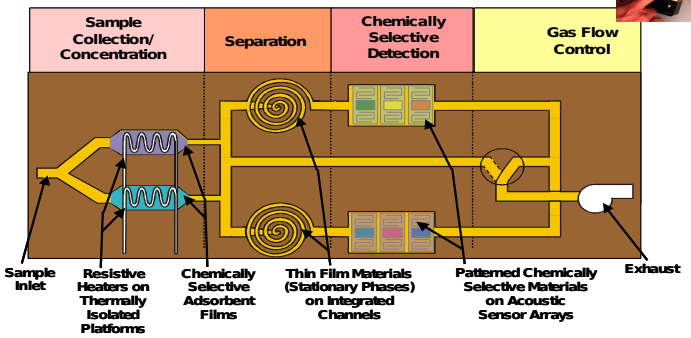
Optimum Approach

- Multiple sensors
- Multiple sample matrix
- Intelligent data analysis
- Sampling control
- Transceiver with network capability
- Integrated single chip design
- On chip power source



DARPA MGA Concept

µChemLab Gas Phase Analysis System



Sandia National Laboratories (SNL) unique u-ChemLab Gas Phase Analysis System

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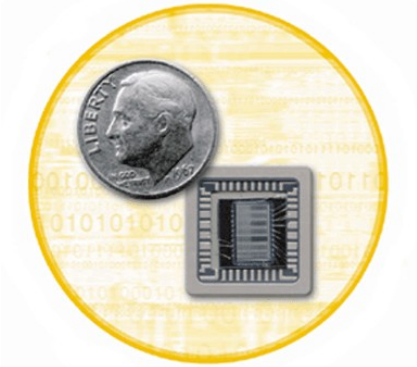
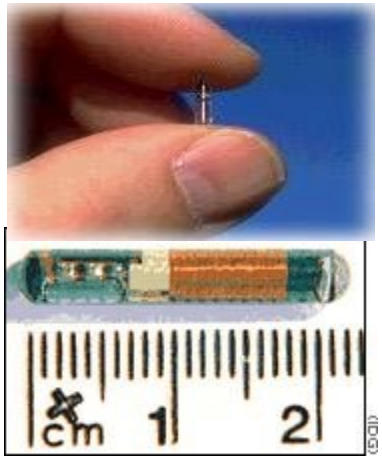
Sensor Systems

- MEMS based sensors
  - Mass spectrometry
  - Temperature/ physiological
  - SAWS / electrochemical
  - Biological
  - Emission / absorption IR/UV/VIS spectrometry
  - Thermal conductivity
  - GPS / motion detectors / camera
- Redundancy & Connectivity
  - Multiple sensors & systems components
  - Built in communications
  - Networking capability
- Low Cost
  - Disposable
  - Cost effective for
    - Individual soldier deployment
    - Unmanned LP / OP deployment
    - Blanketing deployment in hot areas



Cyrano Science NoseChip



Bio Medic Data Systems, Inc. Injectable RFID

Caliper Technologies LabChip with Agilent 2100 Bioanalyzer

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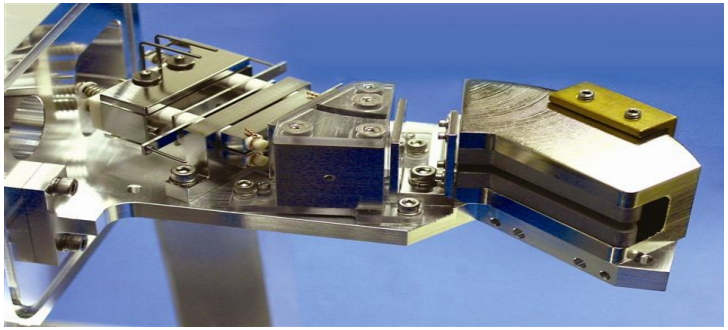
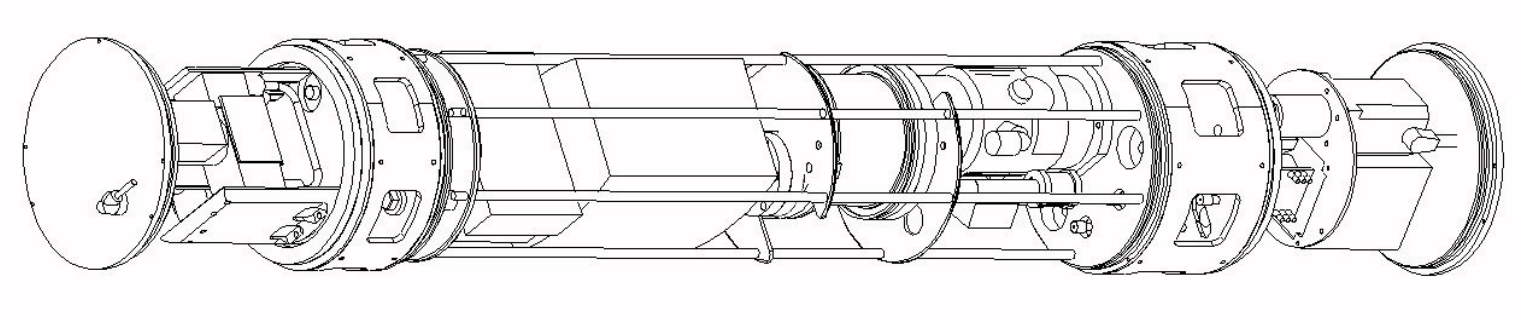
Mini-Micro Mass Spectrometer Approaches



Intelligent Ion Mini Mattauch Herzog Magnetic Sector Mass Spectrometer based on work sponsored by NASA JPL

USF COT Mini and Micro Ion Traps above
Drs. Tim Short and Friso van Ameron
USF Mini Marine Quadrupole MS below



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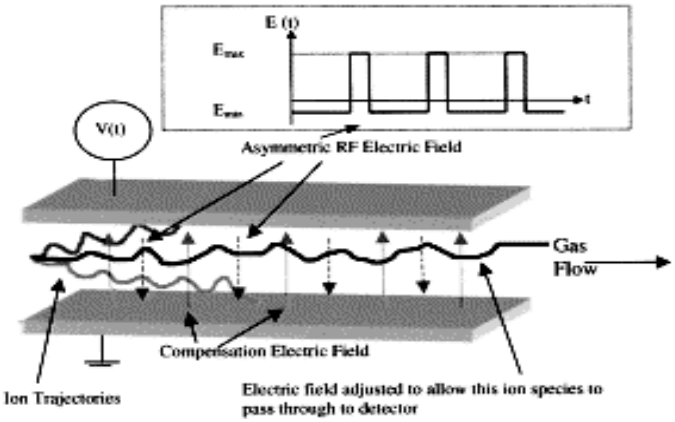
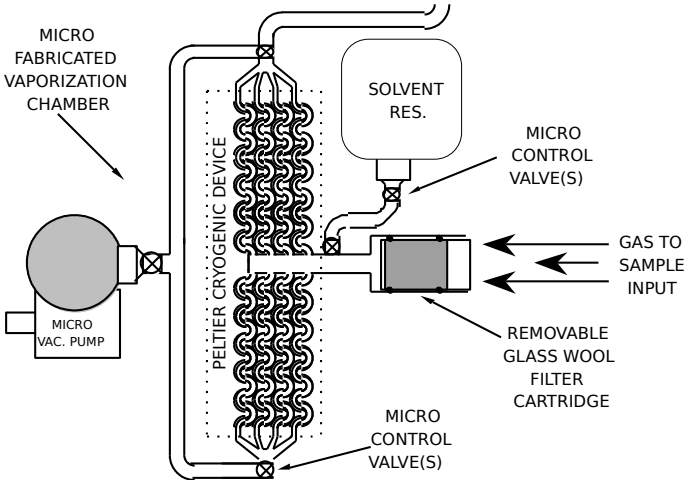
Sampling Optimization

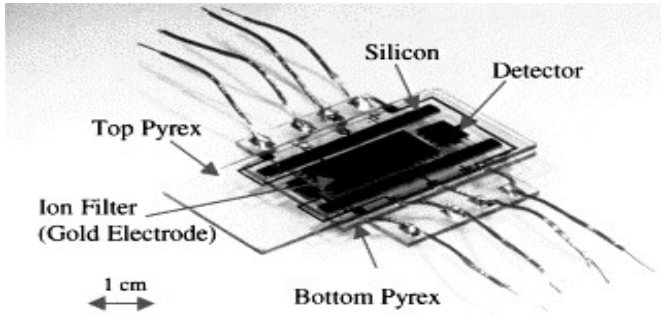
- Physical concentration/ separation
- Selective ion screening
- Sampling for cause



FAIMS Operating Principals and Sionex Micro System



Diffraction LTD Flat Serpentine Sample Accumulator



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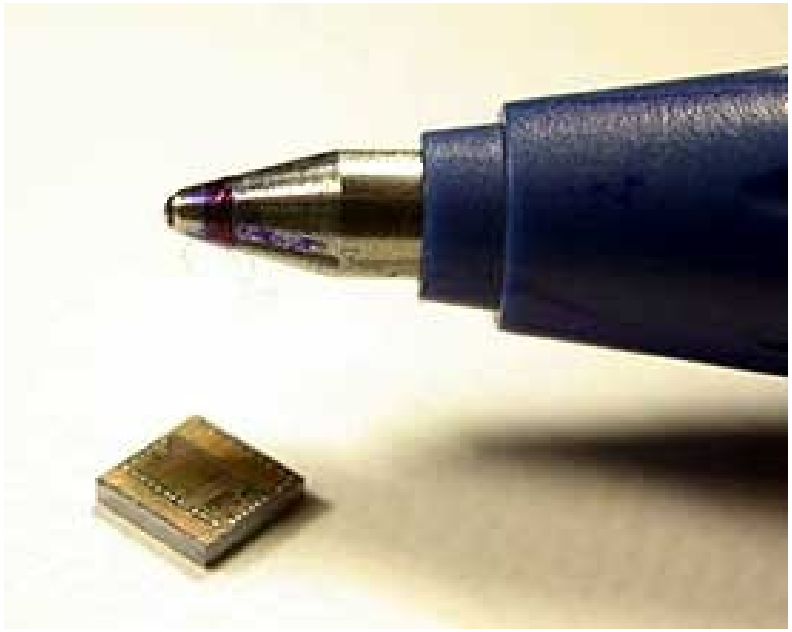
Systems Intelligence/ Communications

- Built-in fingerprint ID ability
- For cause sensor activation for confirmation
- Continuous learning
- Built-in processor
- Built-in transceiver
  - Transmission for cause
  - Transmission for query
  - Transmission per schedule



The single-chip Mote measures approximately 2mm x 2.5mm.

The Mini-mote pictured above was made by under Berkeley's Smart Dust, a research project in the Center for Information Technology Research in the Interest of Society (CITRIS). Invented Professor Kris Pister and is a transceiver-on-a-chip that's 50 times smaller than a cell phone, consumes 1,000 times less power, yet operates at the same frequency.

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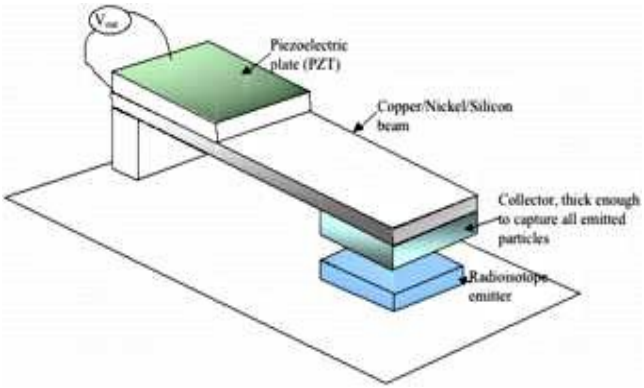
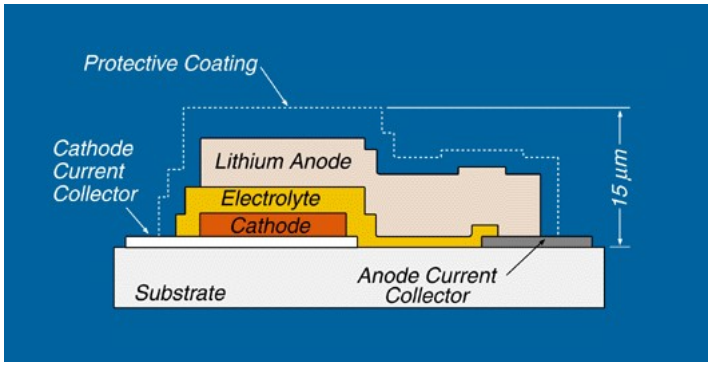
Power

- Sources:
  - Self generating
    - Radioisotopic
    - Solar
  - Battery
  - Fuel cell
- Packaging:
  - System substrate / container
  - Rigid / flexible



Direct Charging Radioisotope Micro Power Generation Cornell University



Solid state rechargeable lithium and lithium-ion batteries which are less than 15 µm (micrometers) thick have been developed at the Oak Ridge National Laboratory. These batteries have high energy and power densities, can be cycled thousands of times, and they can be fabricated in arbitrary shapes and to any required size to meet the requirements of a specific application.

Thin
Ultra-thin design will lead to new generations of battery-powered devices.
Safe
Solid-state electrolyte provides outstanding thermal stability, with no volatile liquids or gels.
Flexible
Exceptional flexibility allows for unprecedented design ingenuity.

Solicore Flexible Polymer Battery

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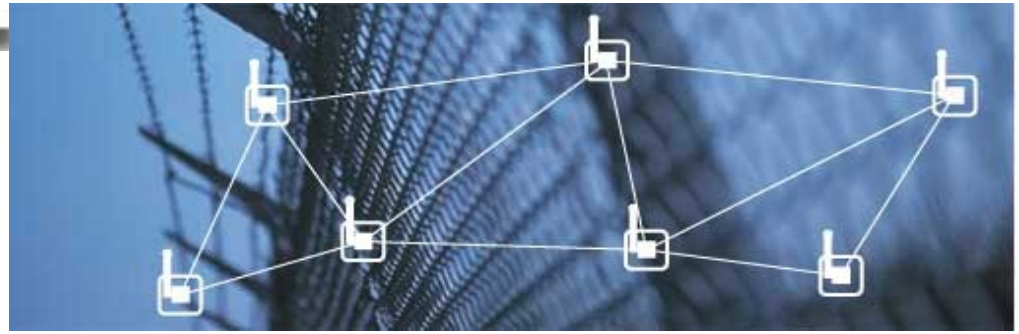
MEMS Sensor Systems Missions

- Sense
  - Treaty compliance
  - Tactical intelligence
  - Covert intelligence
- Shield
  - Smart Clothing
  - Smart Munitions
- Sustain
  - Decontamination support
  - All clear indication



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